

## Topic 2 : Introduction to Networking Continued...

Lectures 4

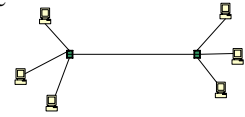
P & D: Pages 2-27

"Computer Networks - A Systems Approach", 3<sup>rd</sup> edition, Larry L. Peterson and Bruce S. Davie, Morgan Kaufman, £34.99.

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## Resource Sharing...

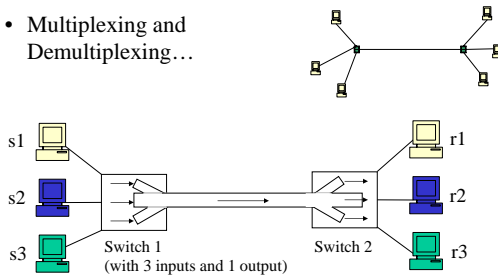
- How do we packet-switch efficiently?
- What if 2 or more hosts are connected to the ends of the same link and they all want to communicate at the same time?
- Similar to concept of timesharing OS that we met earlier, need to share a limited resource between multiple competing demands...



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## Example...

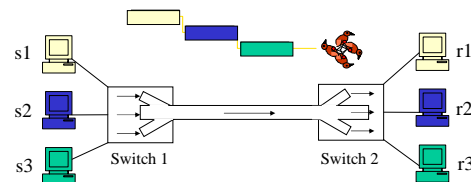
- Multiplexing and Demultiplexing...



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## Sharing the physical link: Possible approaches...

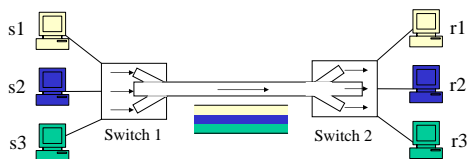
- STDM
  - Synchronous Time Division Multiplexing
  - Split time
  - What if some hosts have nothing to send?



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## Sharing the physical link: Possible approaches...

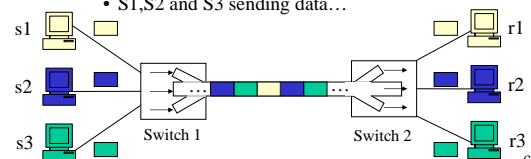
- FDM
  - Frequency Division Multiplexing
  - Split Frequency
    - cf cable TV...
  - Again, what if some hosts have nothing to send?



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## Statistical Multiplexing (1)...

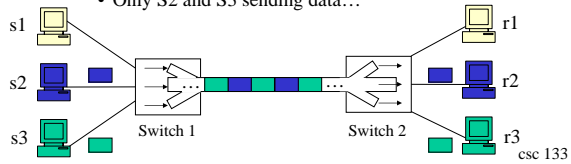
- Statistical Multiplexing...
  - Split messages up into fixed size packets...
  - If a given host doesn't have any data to send then no resources are wasted...
    - S1, S2 and S3 sending data...



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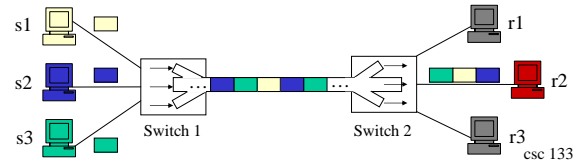
## Statistical Multiplexing (2)...

- Statistical Multiplexing...
  - Split message up into fixed size packets...
  - If a given host doesn't have any data to send then no resources are wasted...
    - Only S2 and S3 sending data...



## Statistical Multiplexing (3)...

- Statistical Multiplexing...
  - The Problem of Congestion...
    - Suppose s1,s2 and s3 all sending to r2...
      - Limitations of link between switch 2 and r2...
      - What happens to the packets???



## Summary so far...

- Need design to cope with diversity
  - Diverse range of possible apps
  - Diverse range of enabling network technologies
- Direct links
  - Point-to-point and Multiple Access
- Indirect links
  - Cloud model and concept of the switched network...
- Packet switched networks
  - Store and forward approach implemented by switches
  - Routing
  - Internet is an example of a packet switched network
  - Multiplexing over links

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## Channels...

- Let's reconsider things from the applications viewpoint... want convenient abstractions...
- Consider earlier apps
  - File transfer
    - e.g. downloading that windows XP patch
    - Client requests file from server
    - **Request/Reply channel**
      - Privacy? Integrity of data flow?
  - Video
    - **Message Stream Channel**
      - Can lose frames but order important

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## Network Architecture...

- Consider reqs... Also networks not static
- Need Abstraction to deal with complexity
  - "...to define a **unifying model** that can capture some important aspect of the system, encapsulate this model in an **object that provides an interface** that can be manipulated by other components of the system, and **hide the details** of how the object is implemented from the users of the object [Peterson & Davie, pp. ]"
  - So want abstractions that provide useful service
    - cf Channels

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## Layering...

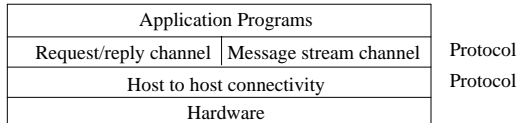
- Implies Layers (cf operating system...)
  - e.g. Low Layer to provide abstraction over raw h/w
  - Another layer provides abstraction over message delivery
  - Service provided by the higher levels implemented using services provided by lower levels
    - i.e. higher level does not have to worry about details of the lower level...



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## Protocols...

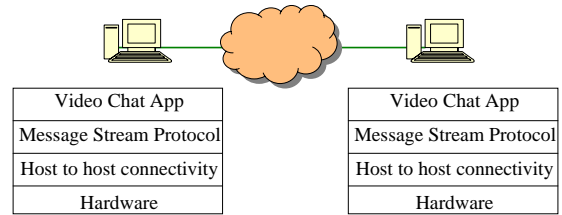
- Name given to the abstract objects that make up the layers of a network system
  - Protocol
  - Protocol specification...



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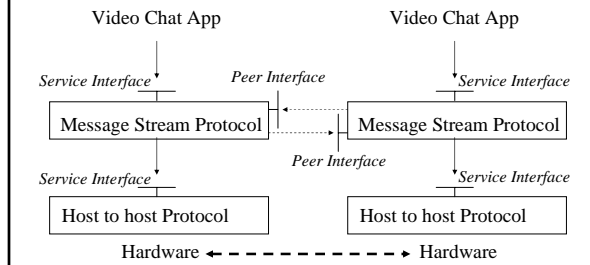
## Example...

- Supporting a video chat between two hosts...



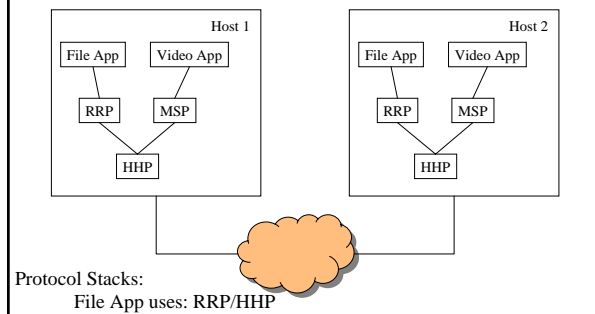
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## Example...



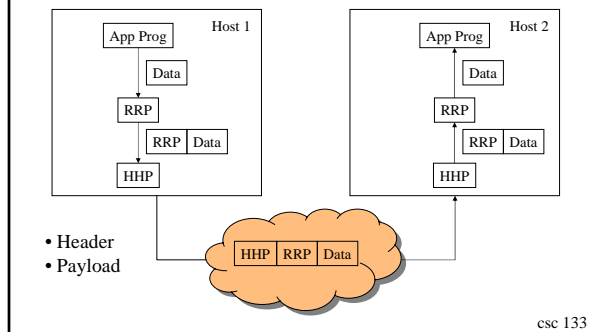
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## Protocol Graphs...



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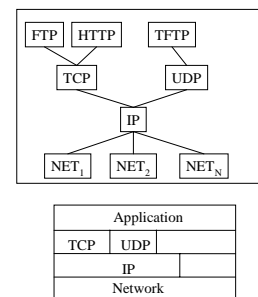
## Encapsulation...



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## The Internet Protocol (TCP/IP)

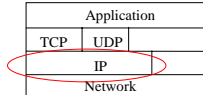
- Note basic hourglass shape...
- Note that it is NOT strictly the case that layering must be adhered to...



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## Internet cont...

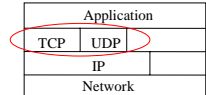
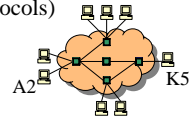
- Evolved from experiences with ARPANET
  - U.S. DoD funded
  - See *resources* for (interesting) background on people, motivations etc...
- IP
  - Supports the interconnection of multiple networking technologies into a single logical network
- Notion of IP packet
  - Contains header + body
  - Header contains destination etc...



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## Layers above IP (1): TCP & UDP

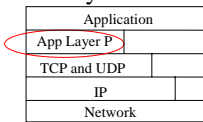
- Logical channels to app programs
  - TCP and UDP (end-to-end protocols)
- TCP
  - Reliable byte stream channel
- UDP
  - Unreliable datagram delivery
    - Packets can be dropped
    - Packets can arrive out of order



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## Layers above IP (2): Application Protocols

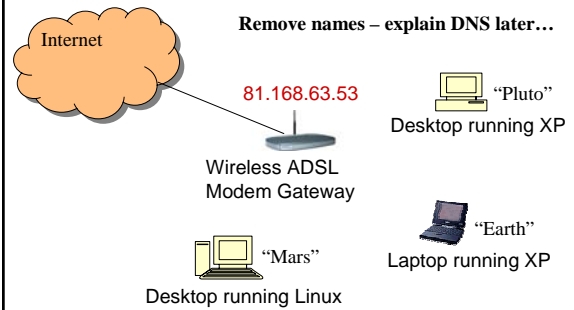
- Consider different Web clients...
  - Netscape, IE etc.
- Consider different Web servers...
  - Apache, Microsoft etc...
- Compatibility due to application layer protocol
  - HTTP



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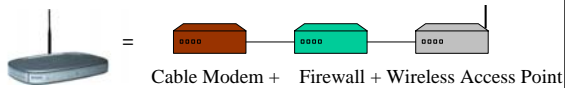
## Case Study 1 – Home Network...

Remove names – explain DNS later...

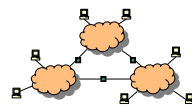


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## Wireless ADSL Firewall Modem Gateway...



- Performs many jobs
  - ADSL "Modem"
    - Connects to my ISP
  - Firewall
  - Internet Router
  - IEEE 802.11b Wireless Access Point
  - DHCP server



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## Gateway acting as a DHCP server

- Acts as a DHCP server
- Assigns addresses to attached devices...



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## Assigning Names...

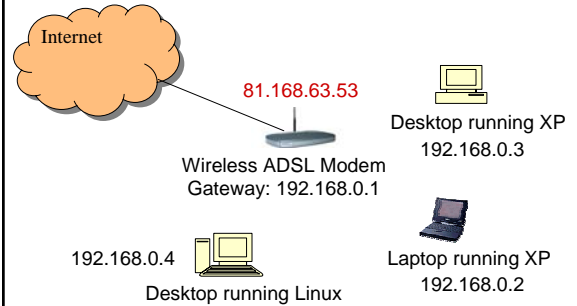
#	IP Addr	Dev Name	MAC Addr
1	192.168.0.2	Earth	00:11:xx:xx:xx:xx



#	IP Addr	Dev Name	MAC Addr
1	192.168.0.2	Earth	00:11:xx:xx:xx:xx
2	192.168.0.3	Neptune	00:1F:xx:xx:xx:xx

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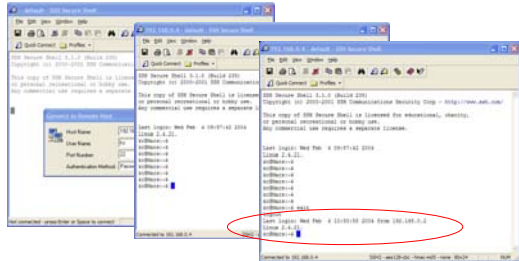
## Case Study 1 – Home Network...



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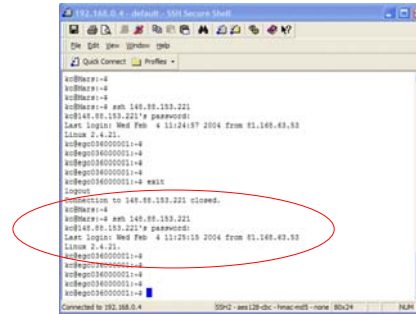
## Example SSH session...

- Performing a remote login from the laptop "Earth" (192.168.0.2) to "Mars" (192.168.0.4)



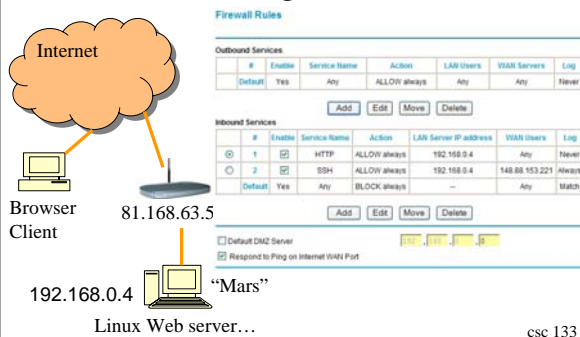
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## ssh'ing from Mars to a host (148.88.153.221) outside our home (private) network...



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## Communicating with outside...



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## Back to single IP address issue... Implications...

- What if I want to run a web server from the linux box?
- And a FTP server from the XP desktop?
- How will routing take place so that a machine from outside knows which internal (private) IP address to connect to?

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